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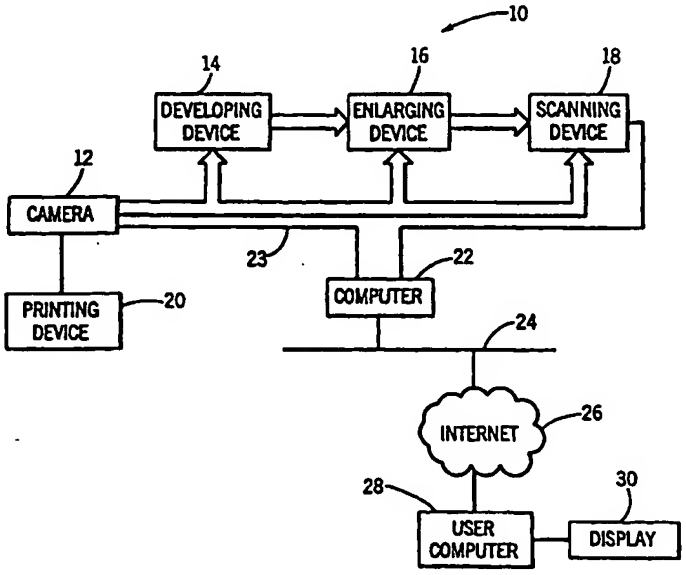
(54) Title: SYSTEM AND METHOD FOR PROVIDING AN ENHANCED DIGITAL IMAGE FILE



(57) Abstract: A method of providing a digital image file for viewing in a viewing window of a user display, the viewing window having a predetermined size. The method includes providing a digital image having an image size comprising a fixed number of pixels representative of an image, the image size being greater than the predetermined viewing window size. The digital image file is associated with a user interface that is configured to display the digital image in the viewing window and to allow a user to zoom into and pan around in the image displayed in the viewing window while maintaining high image quality.

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SYSTEM AND METHOD FOR PROVIDING AN ENHANCED DIGITAL IMAGE FILE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation-in-part of U.S. Patent Application No. 09/522,721, filed March 10, 2000, which claims the benefit of priority from U.S. Provisional Application No. 60/125,824, filed March 24, 1999. The present application also claims the benefit of priority from U.S. Provisional Application Nos. 60/146,726, filed August 2, 1999, 60/149,737, filed August 19, 1999, 60/155,404, filed September 22, 1999, and 60/169,559, filed December 8, 1999.

FIELD OF THE INVENTION

The present invention is directed to a system and a method for producing enhanced digital images and, in particular, to a system and a method for producing enhanced digital images having improved resolution for zooming and/or panning within a single file.

BACKGROUND OF THE INVENTION

In the field of digital imaging, the primary design challenge is that the viewer desires ideal image quality delivered to the viewer's display system. In a limited-bandwidth network, such as the Internet, it is important to transfer the image data in a reasonable amount of time. However, ideal image quality requires an enormous amount of digital data. Today's networks are not capable of transferring an ideal digital image in a reasonable time.

It is known that one can view a digital image on a display screen and "zoom" (i.e., magnify a portion of an image and appearing to move into the image) and "pan" (i.e., move across or around within the plane of that image). However, prior attempts have failed to produce high-quality, high-resolution digital images having the ability to zoom within the

image and pan around the image without pixelation. "Pixelation" generally refers to the effect a digital image has when magnified, in which the pixels (i.e., picture elements) comprising the image become readily apparent to the human eye. More specifically, pixelation occurs when more than one pixel of the display monitor is used to represent one pixel of information of the digitized source image. In prior digital image systems, when the image is magnified, pixelation occurs almost immediately and is very noticeable to the user as a substantial degradation in the quality of the image.

As used herein, the term "pixel" refers to the smallest resolvable element of an image, either on a screen or stored in memory. Each pixel in a monochrome image has its own brightness, from 0 for black to the maximum value (e.g., 255 for an eight-bit pixel) for white. In a color image, each pixel has its own brightness and color, usually represented as a triplet of red, green, and blue intensities.

The teaching in the art is to generate a digital image file having the same number of pixels, or less, as the number that can be shown in a target viewing window. This results in a small source image file size, thereby speeding the transmission of the image file across a network. The target viewing window is typically maintained very small, e.g., 160 x 120 pixels, to further limit the number of pixels needed in the digital image file. Thus, the teaching in the art is to reduce the number of pixels in the digital image file to decrease the size of the image file before compression, so that the compressed image file can be more quickly transmitted over a limited-bandwidth network. However, this teaching has been unsatisfactory in providing high-resolution digital images. It has also been unsatisfactory in providing digital images in large viewing screens, such as, for example, full-sized VGA display monitor screens of 640 x 480 pixels.

Another example of prior systems is mapping or travel web sites. A user selects a desired location and the mapping web site responds by downloading map data from a map database. When the user wishes to zoom into or pan around the selected location, the web site retrieves

additional source data, e.g., additional new map images, and sends it to the user computer. One drawback of this type of system is that each zoom or pan operation requires the downloading of additional data over the network connection. This method is slow, and does not allow the user to zoom and pan around a set of data unless the network connection is maintained.

Accordingly, there is a need for a system and a method for providing enhanced digital images. Further, there is a need for a system and a method for providing enhanced digital images within which a user can zoom or pan without loss of resolution and without pixelation. Further still, there is a need for a system and method for providing enhanced digital images that can be transmitted over a network in a reasonable amount of time. Further yet, there is a need for a system and a method for producing enhanced digital images suitable for uploading and for downloading to a display. Also, there is a need for a system and method for providing a digital image file suitable for efficient file transfers of high resolution digital images, thereby dispensing with the need to engage in long and slow, conventional file downloads in order to maintain viewing quality.

SUMMARY OF THE INVENTION

According to an exemplary embodiment, a method of providing a digital image file for viewing in a viewing window of a user display, the viewing window having a predetermined size, includes providing a digital image file having an image size comprising a fixed number of pixels representative of an image. The image size to be displayed is greater than that of the predetermined viewing window size. The method further includes the step of associating a user interface with the digital image file. The user interface is configured to display the digital image file in the viewing window and to allow a user to zoom into the image displayed in the viewing window.

According to another exemplary embodiment, a method of providing an enhanced digitized image file to a user includes predefining a

viewing window size in which the digitized image file is to be displayed to a user; providing a digitized image file having an image size greater than of the predefined viewing window size; compressing the digitized image file; and providing the compressed image file to a network server.

According to yet another exemplary embodiment, an enhanced digital image file is disclosed. The enhanced digital image file is displayed on a client computer display system having a viewing window, the viewing window having a predetermined frame size. The enhanced digital image file includes digitized image data representative of an image, wherein the digitized image data has a number of pixels sufficient to allow a user to magnify the digitized image in the viewing window by a magnification factor of greater than one without appreciable pixelation. The enhanced digital image file further includes control data associated therewith for permitting the user to control the magnification factor.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will become more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, in which:

FIG. 1 is a block diagram of a system for providing an enhanced digital image file according to an exemplary embodiment;

FIG. 2 is a flowchart of a method for providing an enhanced digital image file from a print film image according to an exemplary embodiment;

FIG. 3 is a screen print of a display screen on a user display illustrating an enhanced digital image file according to an exemplary embodiment;

FIG. 4 is a screen print of a display screen on a user display illustrating a zoomed view of the enhanced digital image of FIG. 3;

FIG. 5 is a screen print of a display screen on a user display illustrating a panned and zoomed view of the enhanced digital image of FIG. 3;

FIG. 6 is a flowchart of a method for providing an enhanced digital image file from a digital image according to an exemplary embodiment; and

FIG. 7 is an illustration relating a source image, a viewing image, and a viewing window to one another.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a system 10 for providing an enhanced digital image file according to an exemplary embodiment. System 10 includes a camera 12 which may be a conventional print film camera, such as, print film cameras manufactured by Nikon, Canon, Hasselblad, Kodak, or other manufacturers, or may alternatively be a digital camera, a digital video recording device (e.g., including 3CCD technology), an analog recording device such as a reel-to-reel recording device, a live video recording system, etc. In the case where camera 12 is a digital camera, camera 12 may further include a solid state storage medium or memory. Camera 12 may be mountable, such as on a tripod or on a stand, hand-held or fixed, and may include a 24-32 mm lens. Camera 12 is utilized to obtain an image of a scene that is being photographed or video recorded. The image may be a print film image (e.g., a high gloss, photographic print), analog image, digital image, negative, transparency, etc.

As a further alternative, system 10 may be utilized in conjunction with any imaging or video recording system, such as, medical imaging equipment. In this case, camera 12 may be an imaging device, such as a magnetic resonance imaging (MRI) device, an X-ray device, a microscope with a camera attached thereto, etc.

In the case where camera 12 is a print film camera, system 10 also includes a developing device 14, which can be any device or collection

of devices, for developing the print film image taken by camera 12. In some cases, such as a POLAROID brand camera, developing device 14 is combined with and integral to camera 12. Developing device 14 is not required in an embodiment in which the image is a digital image.

System 10 also includes an enlarging device 16 for enlarging the image which is developed by developing device 14. The image may be photographically enlarged from a print film image, a negative, or other transparency.

The system of FIG. 1 further includes a scanning device 18, for scanning images or photographs in order to obtain a digitized representation of the source image in the form of a digital image file. Any suitable scanning software may be utilized. In an exemplary embodiment, a UMAX Astra scanner is utilized in conjunction with Microsoft Photo Editor software. Scanning device 18 outputs the digital image file in a bitmapped format (e.g., BMP, TIF, GIF, etc.) The device may include compression software to compress the digital image file into a compressed format (e.g., JPEG). Note that, depending upon the specific type of camera 12 and desired processing steps, a print film image from camera 12 may be provided directly to enlarging device 16 or directly to scanning device 18.

If the source image is obtained with a digital camera of sufficient resolution, the digitized image file from camera 12 may be used directly without first creating a print image. On the other hand, a print image may first be obtained from the camera's digitized source image by sending it to a suitable printing device 20. In this manner, the printed image can then be optically enlarged and scanned to provide the enhanced digitized image.

System 10 also includes a computer 22 configured to process the digital image file created by the above-mentioned devices. Computer 22 may be a personal computer, a laptop computer, a mini computer, a microprocessor, a mainframe computer, a network computer, a server computer, or any other suitable computer or computer system. Computer

22 typically includes a central processing unit (CPU), a read only memory (ROM), a random access memory (RAM), a display device such as an SVGA display monitor, an input device and/or an output device. Computer 22 may also include any other hardware device, peripheral device, or software necessary to perform the functions described herein. The input device may include a keyboard, a mouse, or other pointing device, or other devices for allowing user input. The output device may include a printer (e.g., a black-and-white or color laser or inkjet printer). Computer 22 also includes an interface circuit for transmitting and/or receiving data over a network or link 24, such as, a local area network (LAN), a wide area network (WAN), an internet protocol network (e.g., the Internet, an intranet), a broadcast network, a satellite or cable television network, a digital video transmission path, etc. Computer 22 may further act as a network server or may be in communication with such a network server. Furthermore, as will be seen below, the function of network 24 may be, in a simple case, performed by other components of the system. In this exemplary embodiment, computer 22 is accessible by the Internet 26 via network 24 (e.g., a local area network).

A user computer 28 is used to access the enhanced digital image file stored in or provided by computer 22 (acting as a network server). Computer 28 may also load the image file to a storage device (e.g., a hard disk drive) to be used for display on a display 30. User computer 28 may operate an Internet browser, such as Netscape Navigator configured to communicate with the Internet 26 or an intranet or other network.

Display 30 may be any type of user display, such as a cathode ray tube (CRT), liquid crystal display (LCD), hand-held personal digital assistant (PDA) display, mobile phone display, etc. Display 30 normally has a predetermined display resolution (e.g., 1,280 x 1,024 pixels, 640 x 480 pixels, 320 x 240 pixels, etc.). Note that user computer 28 may be combined with display 30 in a single, integrated system, such as would be

the case for a WebTV brand system, a high-definition television (HDTV), a PDA, etc. The combined user computer and display system may be referred to herein as the display system.

As will be described in more detail below, the computer display system typically has a viewing window on the display for viewing the image in a particular frame. The viewing window may be all or a portion of the total viewing area of display 30. The viewing window parameters, such as the viewing window area size and aspect ratio (i.e., viewing window width divided by viewing window height) may be under the control of user computer 28. In one embodiment, the viewing window area may be no more than 160 x 120 pixels in size, which is just a portion of the display area of an SVGA display monitor at 800 x 600 pixels.

References herein to frame sizes in pixels (such as, 320 x 240 pixels, 640 x 480 pixels, etc.) are intended to include equivalent frame sizes thereto. As an example, when rectangular pixels are used, the exact pixel count differs from the stated frame size. Thus, one equivalent to a 320 x 240 pixel frame size is 352 x 240. Accordingly, references to frame sizes in pixels are intended to included these and other equivalent frame sizes, and the teachings herein include any and all such insubstantial variations.

Referring now to FIGS. 2 and 6, exemplary methods 50 and 100 of providing an enhanced digital image file will be described. The enhanced digital image file can be generated from a print film image or a digital image. The enhanced digital image file is a digitized image acquired with a digital camera, scanner, or other device suitable for digitizing an image into pixels. The method of FIG. 2 is suitable for processing a print film image; the method of FIG. 6 is suitable for processing a digital image.

At step 52 of FIG. 2, an image is photographed or recorded by using camera 12. If camera 12 is a video camera, the video data is captured using a suitable capture device (e.g., an internal or external capture card, a Dazzle LAV-1000S capture device manufactured by Dazzle,

Inc. of Fremont, California, etc.). A single captured frame from the video camera may be further processed as a digital image.

At step 54, the image is developed by developing device 14 in order to produce a photographic print, such as a high gloss photographic print. As mentioned, the step of developing may not be necessary in all cases (e.g., where the print film image of camera 12 is in a suitable format for subsequent enlarging or scanning).

At step 56, the developed image is enlarged by enlarging device 16, if needed. In this exemplary embodiment, the developed image can be enlarged to sizes of between 8"x6" and 8"x12", or to any other appropriate size. The developed image is enlarged to provide additional photo information to scanning device 18. The developed image can be enlarged many times before the granularity of the image is visible to the human eye. A photographic enlargement magnification capability of up to 1700 times or more may be attained for most views or scenes. It is, however, recommended that larger enlargement sizes be obtained for smaller developed images. As mentioned, the step of enlarging may not be necessary in all cases (e.g., where the size of the print film image or developed image is large enough to provide sufficient data to scanning device 18).

At step 58, the enlarged image is scanned by scanning device 18 in order to generate a bitmap image file or other digital image file, such as, JPEG, GIF, or other files. Scanning should be performed at a scan density that will provide the requisite number of pixels in the resulting digital image file (e.g., 100 dpi, 200 dpi, 600 dpi, 1400 dpi, etc.) Contrary to the teachings of the prior art, a large number of pixels are provided in the digital image file such as would be within the particular file size and loading time constraints. According to one example, a sufficient number of pixels are provided in the enhanced digital image file to allow a user to magnify the digitized image in the viewing window of display 30 by a magnification factor of greater than one without pixelation. Alternatively, a sufficient

number of pixels are provided to allow the user to magnify the digitized image by a magnification factor of 1.5, 5, 10, 20, 100, or more.

According to one exemplary embodiment, the number of pixels provided in the enhanced digital image file is based on a viewing window size and the desired magnification ratio. By providing more pixels in the enhanced digital image file than is required for a full-window view in the viewing window, the user is able to zoom and pan within the digital image during viewing without pixelation.

FIG. 7 illustrates the parametric details and relationships between the different images and viewing window sizes. These parameters and description are for the purpose of creating large, clear, zoomable and pannable images from a variety of photographic, source images. First, a "source image" (si) provides the original source of the graphical image information before it is digitally processed, as opposed to a "target image" (ti) that is the destination image to be transferred to the computer display system. In the analog case, the source image is not yet digitized. In other words, it has not been converted to a bitmapped format. A source image could be a photograph, a handwritten sketch, a computer-generated graphic, etc. In this case, source image is what is fed to the scanning device 18. In the digital case, the source image has already been digitized, such as the digital output of a CCD camera taking a photograph.

The source image (si) has a source image height (sih) and a source image width (siw). The source image aspect ratio (sir) is the width of the image divided by the height of the image, generally in inches:

$$sir = siw/sih$$

The viewing window (vw) is the window, defined in pixels, within which the target image, when scaled to fit, is to be displayed as the viewing image (vi). The viewing window (vw) has a viewing window width (vww) and a viewing window height (vwh), both defined in pixels. Thus, the viewing window aspect ratio (vwr) can be determined as:

$$vwr = vww/vwh$$

Note that the source image (si) may have a different aspect ratio than the viewing window (vw). To place the viewing image (vi) in the viewing window (vw), a subset of pixels from the source image (si) must be selected and scaled. The viewing image height (vih) and viewing image width (viw) within the viewing window (vw) can be determined by comparing the source image aspect ratio (sir) to the viewing window aspect ratio (vwr), as shown:

if sir < vwr then:

vih = vwh

viw = vih * sir

but if sir > = vwr then:

viw = vww

vih = viw / sir

This relationship is illustrated in FIG. 7.

Note that the target image (ti) is created from the source image (si), by scaling the image (si) down to fit within the viewing window (vw). When the target image (ti) is scaled down by the desired maximum magnification factor (mmf) to fit within the viewing window (vw), the scaled target image is called the viewing image (vi).

The maximum magnification factor (mmf) is defined as the ratio of the target image area (tia) to the viewing image area (via). This ratio will determine the amount of zoom available without causing the image to distort due to pixelation, i.e., when fewer pixels are in the viewing image being displayed than available in the viewing window. So:

target image area (tia) = tiw x tih

and since

via = viw x vih

then

tia = via x mmf

To obtain the target image width and height:

tiw = squareroot (tia * sir)

tih = tiw / sir

The relationship between the target image and the viewing image is shown in FIG. 7. The relationship between the target image and the viewing window is also shown. A zoom to the maximum level will be shown in the viewing window as illustrated at representation 120 of FIG. 7. By panning the viewing window, every portion of the target image may be viewed from each level of zooming.

To determine the minimum scan density (msd) to avoid pixelation at the desired maximum magnification factor (mmf):

msd = tih/sih.

EXAMPLE 1

Determine the Target Image Area and dimensions, and minimum scan density for the following case:

Source Image = 5" wide x 4" high

Desired Magnification Factor = 20

Source Image Aspect Ratio = 5 / 4 = 1.25

Define the Viewing Window: assume 480w x 320h pixels

Viewing Window Aspect Ratio = 480 / 320 = 1.5

The Source Image Aspect Ratio is < the Viewing Window Aspect Ratio:

1.25 < 1.5 therefore:

vih = vwh = 320 pixels

viw = vwh * 1.25 =320 * 1.25 = 400 pixels

The Viewing Image Area = vis = 320 x 400 = 128,000 pixels

The Target Image Area = vis x 20 = 128,000 x 20 = 2,560,000 pixels

The Target Image width = 2,560,000 / 0.8 = 1789 pixels

The Target Image height = 1789 x 0.8 = 1431 pixels

The Minimum Scan Density = 1789 / 5 = 358 pixels per inch The photo scan can be any scan density > 357 pixels per inch

Thus, a 5 x 4" print film image should be scanned at greater than 357 pixels per inch to allow magnification/zoom up to 20 times in a viewing window of 320 x 240 pixels. An enhanced digital image file

having 2,560,000 pixels provides a sufficient number of pixels for this example.

EXAMPLE 2

Determine the Target Image Area and dimensions, and minimum scan density for the following case:

Source Image = 5" x 4"

Desired Maximum Magnification Factor = 20

Source Image Aspect Ratio = 5 / 4 = 1.25

Define the Viewing Window: assume 400w x 360h pixels

Viewing Window Aspect Ratio = 400 / 360 = 1.11

The Source Image Aspect Ratio is > the Viewing Window Aspect Ratio:

1.25 > 1.11 therefore:

viw = vww = 400 pixels

vih = viw / 1.25 = 400 / 1.25 = 320 pixels

The Viewing Image Area = via = 400 x 320 = 128,000 pixels

The Target Image Area = via x 20 = 128,000 x 20 = 2,560,000 pixels

The Target Image width = 2,560,000 * 1.25 = 1789 pixels

The Target Image height = 1789 / 1.25 = 1431 pixels

The Minimum Scan Density = 1431 / 4 = 358 pixels per inch

The photo scan can be any scan density > 357 pixels per inch

EXAMPLE 3

Determine the Target Image Area and dimensions, and minimum scan density for the following case:

Source Image = 4" wide x 5" high (portrait orientation)

Desired Magnification Factor = 20

Source Image Aspect Ratio = 4 / 5 = 0.8

Define the Viewing Window: assume 400w x 360w pixels

Viewing Window Aspect Ratio = 400 / 360 = 1.11

The Source Image Aspect Ratio is < the Viewing Window Aspect Ratio:

0.8 < 1.11 therefore:

vih = vwh = 360 pixels

viw = vih * 0.8 = 360 * 0.8 = 288 pixels

The Viewing Image area = via = 360 x 288 = 103,680 pixels

The Target Image area = via x 20 = 103,680 x 20 = 2,073,600 pixels

The Target Image width = 2,073,600 * 0.8 = 1288 pixels

The Target Image height = 1288 / 0.8 = 1610 pixels

The Minimum Scan Density = 1610 / 5 = 322 pixels per inch

The photo scan can be any scan density > 321 pixels per inch

Returning now to FIG. 2, at step 60, the enhanced digital image file is provided to computer 22 in a digitized format, i.e., pixel-based, bitmapped, etc. (as opposed to vector graphics based format), such as in either in a bitmap BMP format or a compressed JPEG format. Computer 22 performs a touch-up operation on the scanned image in order to make refinements or enhancements thereto. This touch-up operation is accomplished by utilizing imaging software. Touch-up steps may include cleaning the edges of the image, adjusting lighting, adjusting colors, etc. Adobe PhotoShop software, manufactured by Adobe Systems Inc., San Jose, California, can be used as the imaging software for touching up the images.

According to one example, multiple images can be stitched together after scanning, and before or after compression, thereby creating a panoramic scene or image, or simply a scene requiring a plurality of photographs. This stitching operation can be performed by utilizing photo stitching software such as, for example, Photo Vista software by Live Picture, Live Picture Reality Studio or Live Picture Object Modeler. Stitching may comprise sufficient photos for a 360 degree panoramic image of a scene. If images are stitched, they may be touched-up at step 60.

At step 62, if desired, and if the enhanced digital image file has not yet been compressed (e.g., by scanning device 18 or the touch-up software), the image is then converted from a bitmap file format (e.g., BMP) to a compressed file format (e.g., JPEG). Other compression algorithms are contemplated. Adobe Image Ready software is utilized to perform the BMP-to-JPEG file conversion in this exemplary embodiment.

The compression is set to a very high compression factor, such as, 70% to 90%, but may alternatively be set to other compression factors. The target image area be set as one of the parameters for compression, thus ensuring an optimum compressed file size.

At step 64, user interface or control data is associated with the enhanced digital image file. The user interface data is a program or code segment (e.g., a Java applet) that provides a graphic user interface on display 30 upon loading of the image. The user interface program is associated with the enhanced digital image file such that the combined file or files can automatically launch the graphic user interface, decompress the digital image data, and display at least a portion of the digital image data within a viewing window having a predetermined viewing size on display 30.

The user interface data may alternatively be a plug-in, applet, or other software program, such as, Photo Vista, Reality Studio, or Object Modeler manufactured by Live Picture Inc., San Francisco, California, or an Ipix plug-in manufactured by Internet Pictures Corporation of Oak Ridge, Tennessee. The user interface data may be either associated with the enhanced digital image file such that it is downloaded with the enhanced digital image data, or it may be launched independently from the enhanced digital image data as, for example, an applet or plug-in on user computer 28. If the user interface data is launched independently of the image data, it may either be first opened by the user before downloading the enhanced digital image file, or it may be automatically opened by the enhanced digital image file, such as, via a script or other code segment within the enhanced digital image file.

Referring to FIG. 3, an exemplary screen print 80 from display 30 is shown illustrating the graphical user interface 82 generated by the user interface program. User interface 82 includes a viewing window or frame 84 for displaying the digital image data 86. User interface 82 further includes zoom buttons 88 for allowing the user to zoom into and out of

digital image data 86. By actuating one of zoom buttons 88, user interface program resizes digital image data 86 within viewing frame 84. User interface 82 further includes panning buttons 90 to allow the user to pan up, down, left, and right within image data 86.

Once the user interface program is associated with the enhanced digital image data, the resulting image is ready for providing to a network server, projection from a projector, display system, posting, or playback, to or from a host computer, a Web server, a Web site, or a Web page. At step 66, the enhanced digital image is uploaded to a network server. In the instance where the enhanced digital image is posted to an Internet Web server, the upload from computer 22 to the respective server can be performed by utilizing file uploading software, such as, Web FTP (file transfer protocol) Pro software, manufactured by Ipswitch, Inc., Lexington, Massachusetts.

Referring now to FIGS. 3, 4, and 5, exemplary print screens are shown illustrating the result of an upload or download of the enhanced digital image file to user computer 28 for display on display 30. In FIG. 3, digital image data 86 of a collectible stamp image is shown within a viewing window 84. Although viewing window 84 is slightly smaller than the full-screen size of display 30 (e.g., 640 x 480 pixels in this example), viewing window 84 can alternatively be configured for full-screen display, or display in other sizes or resolutions. As shown, digital image data 86 shows no sign of pixelation.

In FIG. 4, a user has actuated zoom buttons 88 to zoom-in to the digital image. In response, the user interface program provides additional digital image data from the enhanced digital image file stored in a memory (e.g., a hard drive) of user computer 28, to provide a zoomed view of the digital image. Thus, the view of FIG. 4 also shows little sign of pixelation even though the image has been magnified many times.

In FIG. 5, a user has actuated pan buttons 90 to display the lower left-hand corner of the digital image data within viewing window 84.

The user has also actuated zoom buttons 88 to zoom-in to the digital image data. Again, little pixelation is visible.

As mentioned, the principles described herein are also operable with a digital image taken by a digital camera. Referring now to FIG. 6, a method 100 of providing an enhanced digital image file utilizing a digital camera is shown. At step 102, the digital camera is configured to acquire a digital image. In this step, the camera is set with a high resolution to acquire at least enough pixels for a magnification of two times the size of the viewing window provided on display 30, though higher numbers of pixel data may also be acquired.

Again referring to FIG. 7 and the corresponding description hereinabove, with a digital source image, the maximum magnification factor (mmf) should not produce a target image larger than the source image in pixels because of the pixel distortion or pixelation effect, i.e., distortion due to fewer pixels in the image being displayed than available in the viewing window. Since:

target image area (tia) = tiw x tih = via x mmf

then to obtain the target image width and height:

tiw = tia * sir

tih = tiw / sir

If tih > sih then set tih = sih and tiw = siw

EXAMPLE 4

Determine the Target Image size and dimensions, and minimum scan density for the following case:

Source Image = 1600 x 1200 pixels

Desired Magnification Factor = 20

Source Image Aspect Ratio = 1600 / 1200 = 1.33

Define the Viewing Window: assume 480w x 360h pixels

Viewing Window Aspect Ratio = 480 / 360 = 1.33

The Source Image Aspect Ratio is = the Viewing Window Aspect Ratio:

0.75 = 0.75 therefore:

vih = vwh = 360 pixels

viw = vih * 1.33 = 360 * 1.33 = 480 pixels

The Viewing Image area = via = 480 x 360 = 172,800 pixels

The Target Image area = via x 20 = 172,800 x 20 = 3,456,000 pixels

The Target Image width = 3,456,000 * 1.33 = 2147 pixels

The Target Image height = 2147 / 1.33 = 1610 pixels

But tih of 1610 pixels is > 1200 pixels therefore:

tih = 1200 pixels

tiw = 1600 pixels

tia = 1200 x 1600 = 1,920,000 pixels

Effective Maximum Magnification Factor = tia / via

= 1,920,000 / 172,800 = 11.1

The Minimum Scan Density = N/A

Steps 104 (touch-up image), 106 (compress file), 108 (associate user interface data), and 110 (upload file) may proceed as described with reference to FIG. 2 in the print film image exemplary method.

The above method can be repeated using different depth images or digital photographs for the images in order to create areas of higher resolution or "hot spots" within an image for detailed close-up inspection or viewing. These depth images can be linked to the respective image or image segment. The above method can be utilized in order to create higher zoom capabilities with each new depth layer of an image.

The above method can be utilized for applications including single images, single panoramic images, stitched images, non-stitched images or any other suitable image type.

The system and method of the present invention can also be utilized in conjunction with three-dimensional images in order to produce high resolution, three-dimensional digital images and 3-D texturings.

The resulting images which are obtained via the exemplary system and method are characterized by a high definition resolution and are suitable for high definition television, Web television, and large, panoramic

or object models, Internet applications, which preserve resolution upon image magnification or reduction. The exemplary embodiment also dispenses with the need for plug-in software during download or file transfer operations.

EXAMPLE 5

A variety of photographs were taken using several different types of cameras. A digital camera was used to take several digital images. A Hasselblad camera was used to take several print film images, some of which were 2 ¼" square and others of which were 4 x 5" square. The print film images were taken to a film developing center to be enlarged to 8 x 12" pictures.

The enlarged pictures were scanned with UMAX Astra scanner using Adobe Photo Editor. Some bitmap files were created and some JPEG files were created. In spite of conventional teaching to the contrary, the scanner was set for a high resolution: 600 dpi. For the JPEG files, compression was set to 30:1.

Some of the images were stitched together using Photo Vista. The stitched images were then compressed at a high ratio of compression to generate JPEG files. The compressed files were touched up using Adobe Photo Editor and then uploaded to an Internet server. The uploaded files were then downloaded from the Internet server. The download took only a short time. The images were observed to have exceptionally high quality.

In review, a method is disclosed of providing a digital image file for viewing in a viewing window of a user display, the viewing window having a predetermined size. The method includes providing a digital image having an image size comprising a fixed number of pixels representative of an image, the image size being greater than the predetermined viewing window size. The digital image file is associated with a user interface that is configured to display the digital image in the viewing window and to

allow a user to zoom into and pan around in the image displayed in the viewing window while maintaining high image quality.

While the exemplary embodiments illustrated in the FIGS. and described above are presently preferred, it should be understood that these embodiments are offered by way of example only. For example, the specific pixel counts and display sizes disclosed herein are merely exemplary and are used to illustrate the pertinent principles. Also, not all of the steps of the exemplary embodiments need be performed in all embodiments, nor need they be performed in the specific order recited. Accordingly, the present invention is not limited to a particular embodiment, but extends to various modifications that nevertheless fall within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A method of providing a digital image file for viewing on a user display in a viewing window having a predetermined size, the method comprising:

providing a digital image file having an image size comprising a fixed number of pixels representative of an image, wherein the image size is greater than that of the predetermined viewing window size.

2. The method of claim 1, further comprising providing a user interface for the digital image file, the user interface configured to display the digital image file in the viewing window and to allow a user to zoom into the image displayed in the viewing window,

3. The method of claim 1, wherein the image size is at least ten times that of the predetermined viewing window size.

4. The method of claim 1, wherein the user interface is configured to allow the user to pan across the image.

5. The method of claim 1, wherein the user interface prevents the user from zooming into the image to the point of pixelation.

6. The method of claim 1, wherein the digital image file includes the user interface in a single data file.

7. The method of claim 1, wherein the user interface is an application program applet.

8. The method of claim 1, wherein the user interface is an application program controlled by the user's computer.

9. The method of claim 1, further comprising compressing the digital image file.

10. The method of claim 1, further comprising uploading the digital image file to a network server.

11. The method of claim 1, wherein the digital image file is generated from a print film image.

12. The method of claim 1, wherein the digital image file is acquired with a digital camera.

13. The method of claim 1, wherein the predetermined size represents a full-screen size of the user display.

14. A method of providing an enhanced digitized image file to a user, comprising:

providing a viewing window size in which the digitized image file is to be displayed to a user;

providing a digitized image file having an image size greater than that of the predefined viewing window size;

compressing the digitized image file; and

providing the compressed image file to a network server.

15. The method of claim 13, further comprising:

under user control, transmitting the compressed image file over the network;

displaying the transmitted image file to the user in a viewing window having the predefined viewing window size; and

under user control, magnifying the displayed image within the viewing window.

16. The method of claim 14, further comprising, under user control, moving the displayed image in the predefined viewing window size.

17. The method of claim 14, further comprising providing the user with a plurality of selectable magnification levels to view the displayed image within the viewing window.

18. The method of claim 14, wherein the resolution of the digitized image is greater than that of the image displayed to the user in the predefined viewing window size without image magnification.

19. The method of claim 16, wherein the selectable magnification levels are limited such that no more than one pixel of the user display can display one pixel of the digitized image.

20. The method of claim 13, wherein the digitized image file is compressed to a JPEG format.

21. The method of claim 13, wherein the step of generating includes enlarging and scanning a print film image to provide the digitized image file.

22. The method of claim 19, wherein the print film image is scanned with a density of at least 100 dots per inch.

23. The method of claim 13, wherein the step of generating includes acquiring the digitized image file with a digital camera.

24. The method of claim 13, wherein the compressed image file is accessible via the Internet.

25. The method of claim 14, wherein magnifying the displayed image does not degrade the image quality.

26. An enhanced digital image file downloadable to a client computer having a viewing window on a display, the viewing window having a predetermined frame size, the digital image file comprising:

digitized image data representative of an image, wherein the digitized image data has a number of pixels sufficient to allow a user to magnify the digitized image in the viewing window by a magnification factor of at least two without pixelation; and

control data to allow the user to control the magnification factor.

27. The enhanced digital image file of claim 25, wherein the digitized image data is compressed.

28. The enhanced digital image file of claim 25, wherein the control data is configured to provide zoom buttons and pan buttons to a user.

29. The enhanced digital image file of claim 27, wherein the control data includes a Java applet.

30. The enhanced digital image file of claim 25, wherein the digitized image data has a number of pixels sufficient to allow a user to magnify the digitized image in the viewing window by a magnification factor of at least ten without pixelation.

31. The enhanced digital image file of claim 25, wherein the digitized image data has a number of pixels sufficient to allow a user to magnify the digitized image in the viewing window by a magnification factor of at least one hundred without pixelation.

32. The enhanced digital image file of claim 25, wherein the control data is configured to prevent the user from magnifying the digitized image to the point of pixelation.

FIG. 1

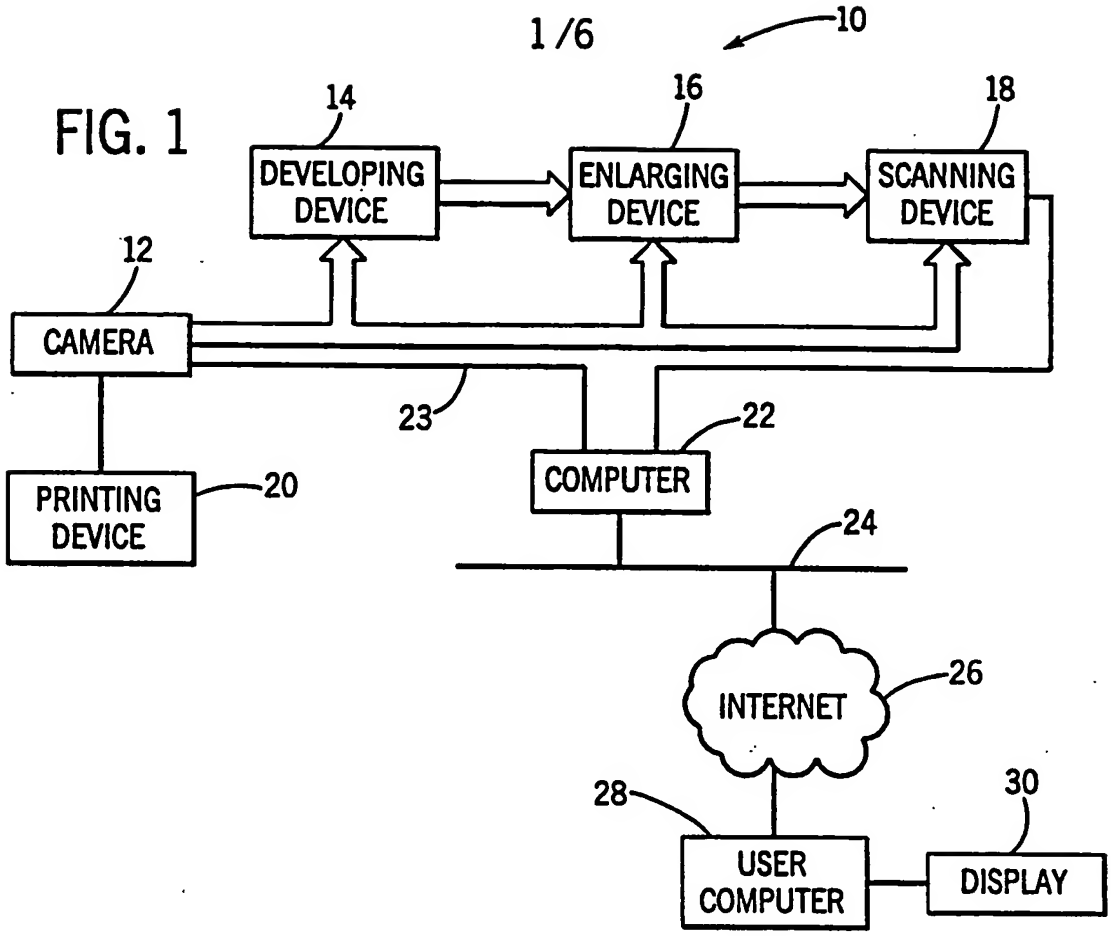
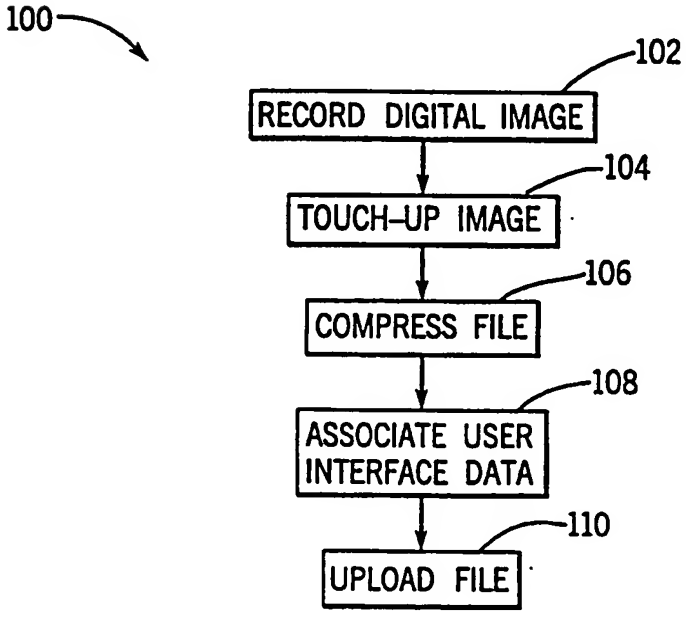

10
14
DEVELOPING DEVICE
16
ENLARGING DEVICE
18
SCANNING DEVICE
12
CAMERA
23
22
COMPUTER
PRINTING DEVICE
20
24
INTERNET
26
28
30
USER COMPUTER
DISPLAY

FIG. 6


100
102
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104
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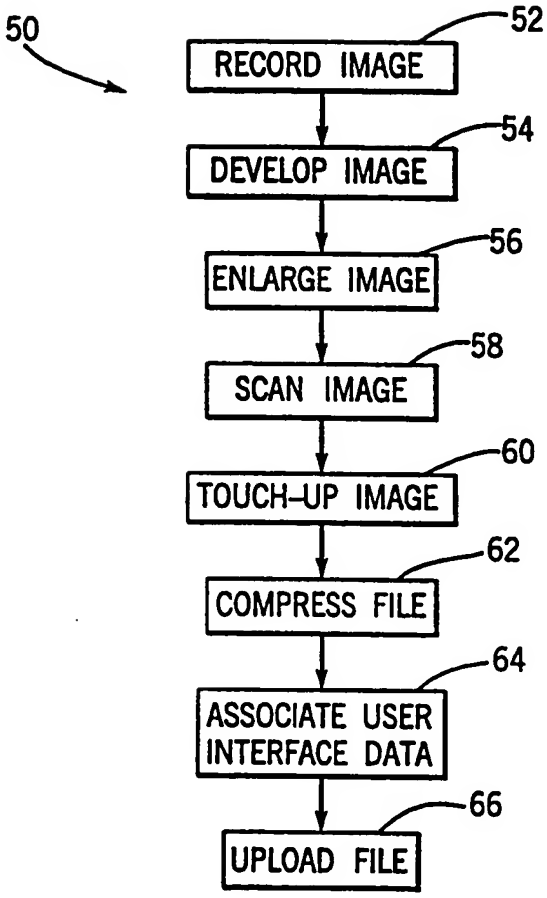
106
COMPRESS FILE
108
ASSOCIATE USER INTERFACE DATA
110
UPLOAD FILE

FIG. 2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52
DEVELOP IMAGE
54
ENLARGE IMAGE
56
SCAN IMAGE
58
TOUCH-UP IMAGE
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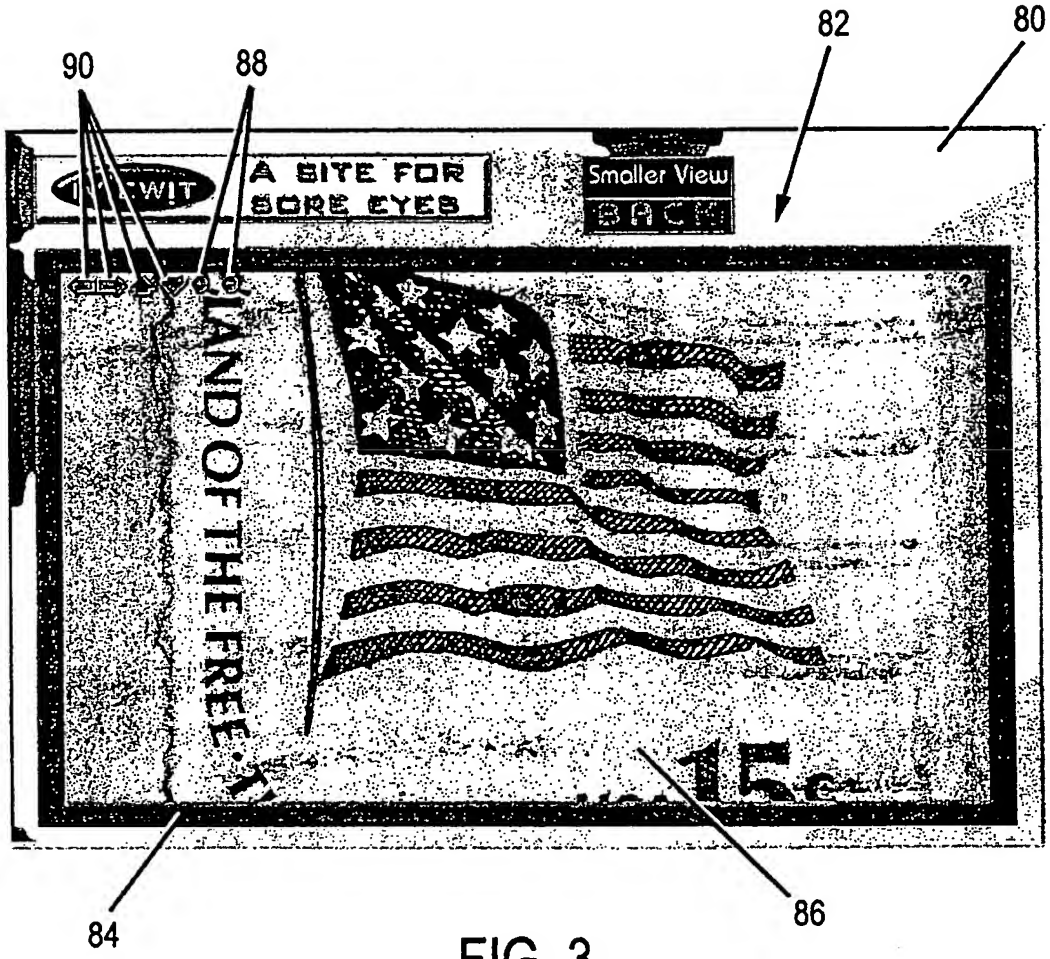
COMPRESS FILE
62
ASSOCIATE USER INTERFACE DATA
64
UPLOAD FILE
66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80
90
88
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Smaller View
BACK
LAND OF THE FREE
15
84
86

FIG. 3

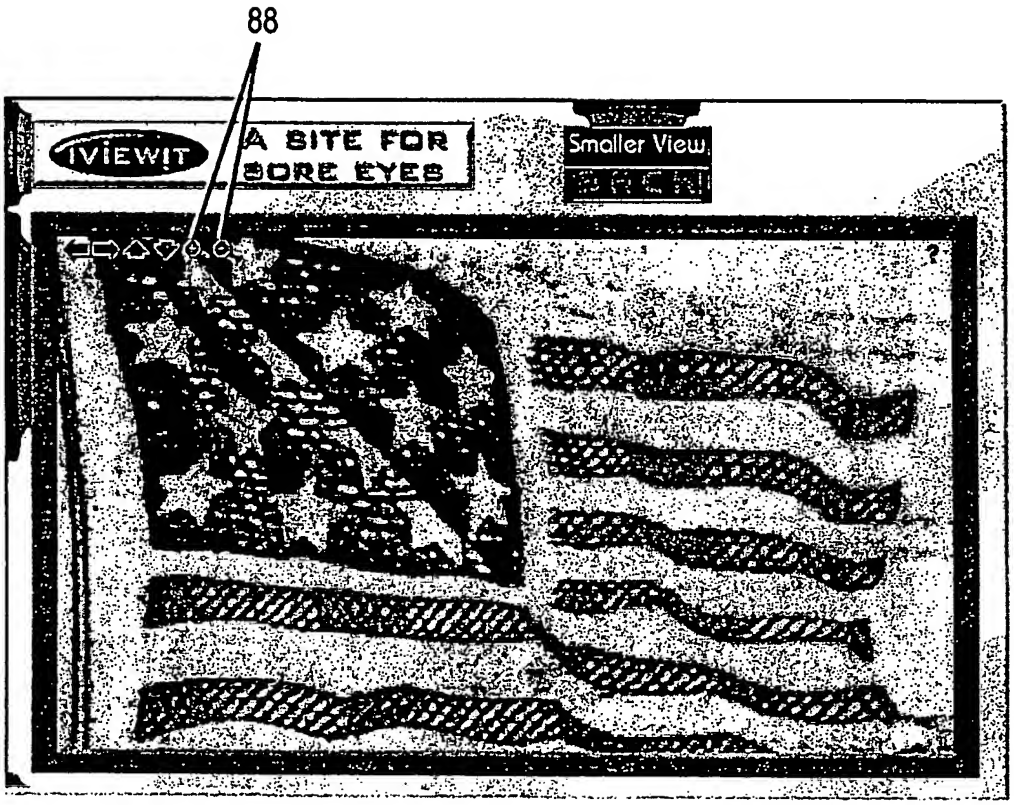


FIG. 4

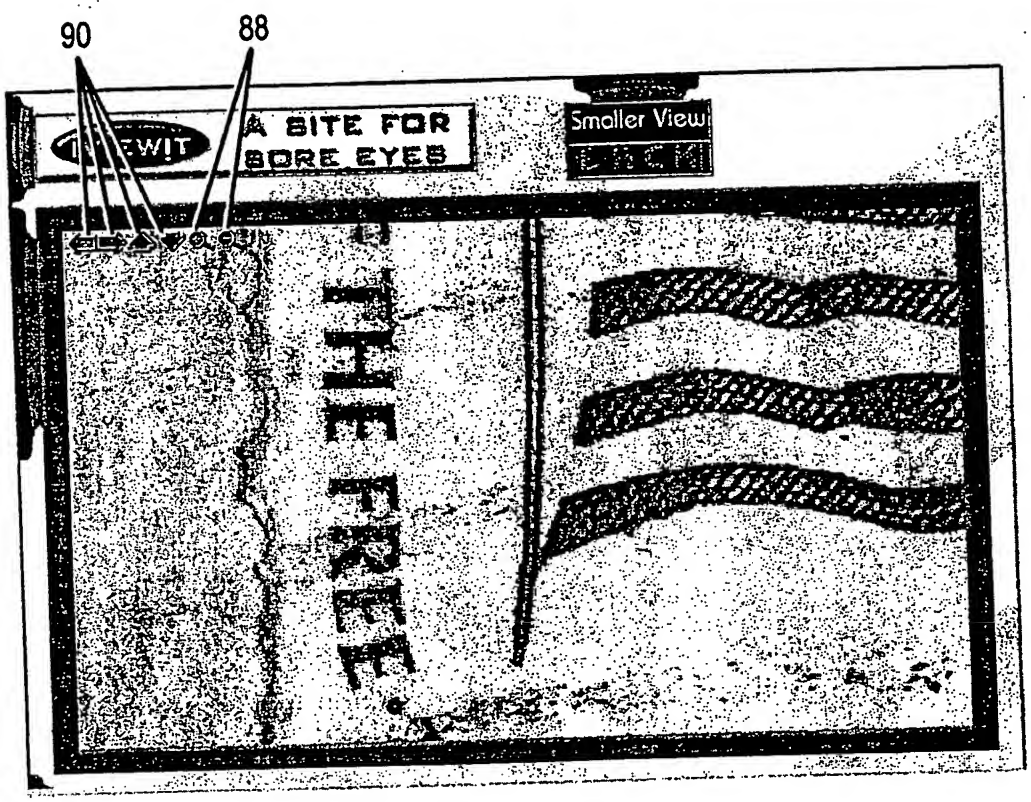
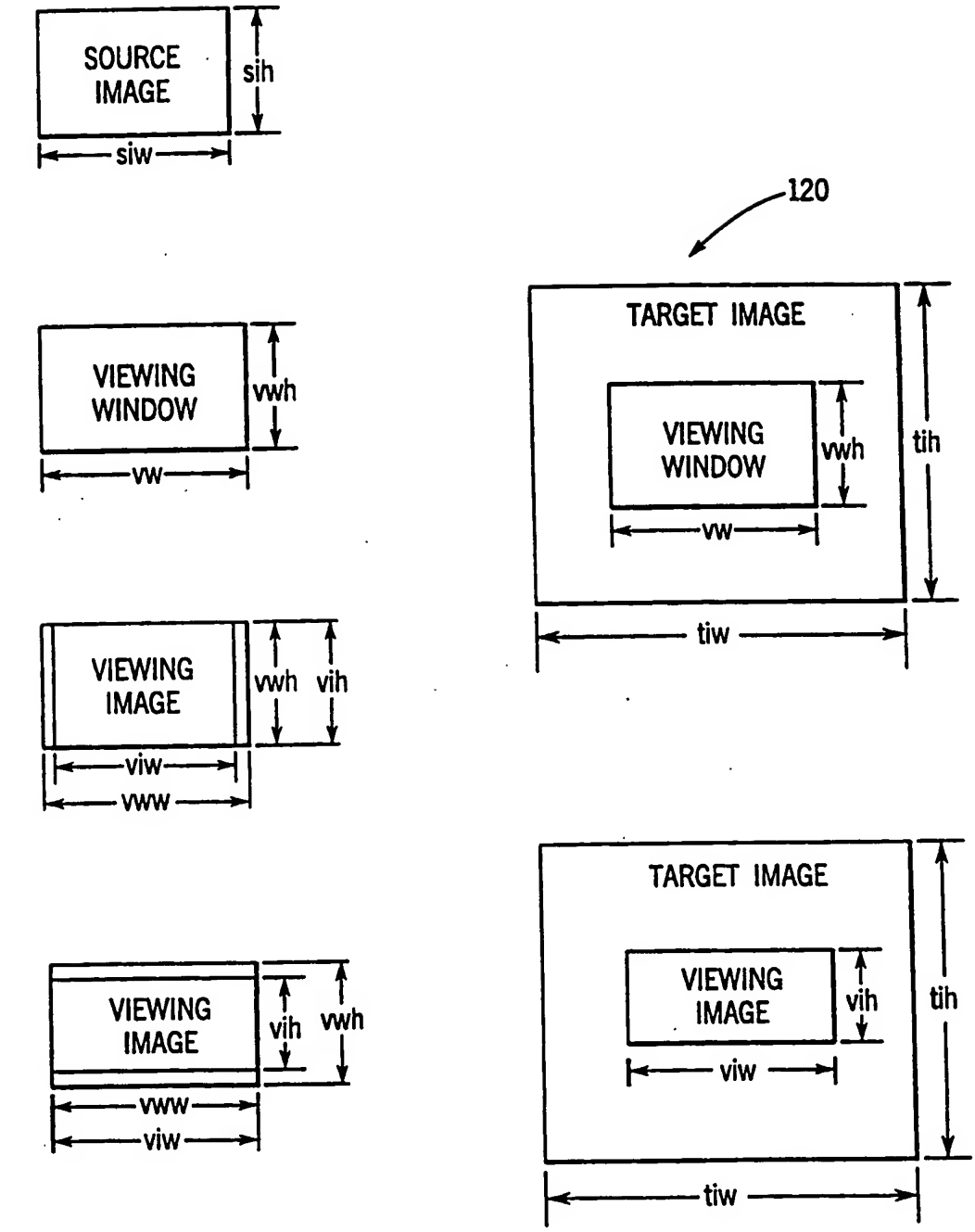


FIG. 5


SOURCE IMAGE
sih
siw
120
TARGET IMAGE
VIEWING WINDOW
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vw
tih
tiw
VIEWING IMAGE
vwh
vih
viw
vww
TARGET IMAGE
VIEWING IMAGE
vih
viw
tih
tiw
VIEWING IMAGE
vih
vwh
vww
viw

FIG. 7

INTERNATIONAL SEARCH REPORT

Interna l Application No
PCT/US 00/21211

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06T3/00 H04N1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06T H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	"ImageZoom 1.0 (Applet)" WORLD WIDE WEB, 'Online! 11 June 1999 (1999-06-11), XP002150186 Resource Collection Retrieved from the Internet: <URL:http://www.digitalcats.com/US/search/rid00004281.html http://www.vivaorange.com/ImageZoom/> 'retrieved on 2000-10-16! the whole document ---	1-32
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 October 2000	30/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Giannotti, P

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5 125 043 A (KARLSSON MAGNUS) 23 June 1992 (1992-06-23) abstract	1-32
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat[illegible] Application No
PCT/US 00/21211

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